CLAIMS

WHAT IS CLAIMED IS:

1. A process for producing hydrocarbons, comprising:

contacting a feed stream comprising carbon monoxide and hydrogen with a bulk cobalt-based catalyst so as to convert at least a portion of said feed stream to hydrocarbons,

wherein the bulk cobalt-based catalyst comprises an average cobalt oxide crystallite size between 10 and 40 nm, and has a surface area between 10 and 150 m^2/g, and further comprises

between 40 and 90 percent by weight of cobalt;

a textural promoter selected from the group consisting of zirconium, chromium, magnesium, cerium, and titanium;

optionally, a Group I metal; and

between 5 and 60 percent by weight of a binder selected from the group consisting of silica, alumina, and combinations thereof.

2. The process of claim 1 wherein the textural promoter is zirconium.

3. The process of claim 2 wherein the bulk cobalt-based catalyst comprises between about 2 and about 5 percent zirconium by weight.

4. The process of claim 1 wherein the bulk cobalt-based catalyst further comprises a Group I metal.

5. The process of claim 4 wherein the Group I metal is potassium.

6. The process according to claim 1 wherein the bulk cobalt-based catalyst has an attrition loss less than 40%.

7. The process of claim 1 wherein the bulk cobalt-based catalyst is made by a method that comprises

(a) forming a cobalt precipitate, wherein said forming a precipitate comprises mixing a cobalt compound and a compound of a textural promoter with a precipitating agent so as to cause precipitation of said compounds;

(b) mixing said cobalt precipitate with a binder derived from at least 2 binder precursors so as to form a slurry;

(c) drying said slurry in a spraydrier so as to form a bulk material precursor in the form of particles; and

(d) calcining the bulk material precursor at a temperature between about 200°C and about 900°C so as to form the bulk cobalt-based catalyst.

8. The process of claim 7 wherein the binder is silica, and the binder is derived from silicic acid and colloidal silica sol.

9. The process of claim 7 wherein the method further comprises adding a precursor of a Group I metal to the mixture in step (a) or to the slurry in step (b).

10. The process of claim 7 wherein the precipitating agent comprises urea, sodium carbonate, ammonium carbonate, or ammonium hydroxide.

11. The process of claim 1 wherein the bulk cobalt-based catalyst is made by a method that comprises

(a) forming a cobalt precipitate, wherein said forming a precipitate comprises mixing a cobalt compound and a compound of a textural promoter with a precipitating agent so as to cause precipitation of said compounds;

(b) mixing said cobalt precipitate with a binder so as to form a slurry;

(c) drying said slurry in a spraydrier so as to form a bulk material precursor in the form of particles;

(d) calcining the bulk material precursor at a temperature between about 200°C and about 900°C so as to form a bulk cobalt-based catalyst; and further

wherein the method includes an acid treatment step comprising treating the cobalt precipitate with an acidic solution or treating the bulk cobalt-based catalyst with an acidic solution.

12. The process according to claim 11 wherein said binder in Step (b) is in the form of a colloidal sol, a binder precursor, or combination thereof.

13. The process according to claim 11 wherein said binder comprises silica, and the binder in Step (b) is in the form of silicic acid, colloidal silica sol, or combination thereof.

14. The process according to claim 11 wherein the acidic solution comprises nitric acid.

15. The process of claim 11 wherein the method further comprises adding a precursor of a Group I metal to the mixture in step (a) or to the slurry in step (b).

16. The process of claim 15 wherein the group I metal comprises potassium.

17. The process of claim 1 wherein said hydrocarbons comprise hydrocarbons with 5 or more carbon atoms.

18. A bulk cobalt-based catalyst comprising

between 40 and 90 percent by weight of cobalt;

a textural promoter selected from the group consisting of zirconium, chromium, magnesium, cerium, and titanium.;

optionally a Group I metal, and

between 5 and 60 percent by weight of a binder selected from the group consisting of silica, alumina, and combinations thereof;

wherein the bulk cobalt-based catalyst comprises a plurality of cobalt oxide crystallites of various sizes, has an average cobalt oxide crystallite size between 10 and 40 nm, and has a surface area between 10 and 150 m^2/g.

19. The bulk cobalt-based catalyst of claim 18 wherein the textural promoter comprises zirconium.

20. The bulk cobalt-based catalyst of claim 19 wherein the catalyst comprises between about 2 and about 5 percent zirconium by weight.

21. The bulk cobalt-based catalyst of claim 19 wherein the bulk cobalt-based catalyst has an attrition loss less than 40%.

22. The bulk cobalt-based catalyst of claim 19 wherein the bulk cobalt-based catalyst has an attrition loss less than 30%.

23. The bulk cobalt-based catalyst of claim 19 wherein the bulk cobalt-based catalyst has an attrition loss less than 20%.

24. The bulk cobalt-based catalyst of claim 18 further comprising a Group I metal.

25. The bulk cobalt-based catalyst of claim 24 wherein the Group I metal is potassium.

26. The bulk cobalt-based catalyst of claim 25 wherein the catalyst comprises between about 0.05 and 5 percent potassium by weight.

27. A method of making a bulk cobalt-based catalyst comprising:

(a) forming a cobalt precipitate, wherein said forming a precipitate comprises mixing a cobalt compound and a compound of a textural promoter with a precipitating agent so as to cause precipitation of said compounds;

(b) mixing said cobalt precipitate with a binder so as to form a slurry;

(c) drying said slurry in a spraydrier so as to form a bulk material precursor in the form of particles;

(d) calcining the bulk material precursor at a temperature between about 200°C and about 900°C so as to form a bulk cobalt-based catalyst; and further

wherein the method includes an acid treatment step comprising treating the cobalt precipitate with an acidic solution or treating the bulk cobalt-based catalyst with an acidic solution.

28. The method of claim 27 wherein the precipitating agent comprises urea, sodium carbonate, ammonium carbonate, or ammonium hydroxide.

29. The method according to claim 27 wherein said binder in Step (b) is in the form of a colloidal sol, a binder precursor, or combination thereof.

30. The method according to claim 27 wherein said binder comprises silica, and the binder in Step (b) is in the form of silicic acid, colloidal silica sol, or combination thereof.

31. The method according to claim 27 wherein the acidic solution comprises nitric acid.

32. The method of claim 27 wherein the method further comprises adding a precursor of a Group I metal to the mixture in step (a) or to the slurry in step (b).

33. The method of claim 27 wherein the Group I metal comprises potassium.

34. The method of claim 27 wherein the bulk cobalt-based catalyst comprises a plurality of cobalt oxide crystallites of various sizes, and has an average cobalt oxide crystallite size between 10 and 40 nm.

35. The method of claim 27 wherein the bulk cobalt-based catalyst has a surface area between 10 and 150 m^2/g.

36. A method of making a bulk cobalt-based catalyst comprising:

(a) forming a cobalt precipitate, wherein said forming a precipitate comprises mixing a cobalt compound and a compound of a textural promoter with a precipitating agent so as to cause precipitation of said compounds;

(b) mixing said cobalt precipitate with a binder derived from at least 2 binder precursors so as to form a slurry;

(c) drying said slurry in a spraydrier so as to form a bulk material precursor in the form of particles; and

(d) calcining the bulk material precursor at a temperature between about 200°C and about 900°C so as to form the bulk cobalt-based catalyst.

37. The method of claim 36 wherein the binder is silica, and the binder is derived from silicic acid and colloidal silica sol.

38. The method of claim 36 wherein the method further comprises adding a precursor of a Group I metal to the mixture in step (a) or to the slurry in step (b).

39. The method of claim 36 wherein the precipitating agent comprises urea, sodium carbonate, ammonium carbonate, or ammonium hydroxide.

40. The method of claim 36 wherein the bulk cobalt-based catalyst comprises a plurality of cobalt oxide crystallites of various sizes, and has an average cobalt oxide crystallite size between 10 and 40 nm.

41. The method of claim 36 wherein the bulk cobalt-based catalyst has a surface area between 10 and 150 m^2/g.

42. The method of claim 36 wherein the bulk cobalt-based catalyst has an attrition loss less than 40%.